

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of : Customer Number: 53080
Yasuo TAKEBE, et al. : Confirmation Number: 5764
Application No.: 10/696,505 : Tech Center Art Unit: 1795
Filed: October 30, 2003 : Examiner: Raymond Alejandro
:

For: METHOD OF OPERATING FUEL CELL SYSTEM AND FUEL CELL SYSTEM AND FUEL SYSTEM

TRANSMITTAL OF APPEAL BRIEF

Mail Stop Appeal Brief
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

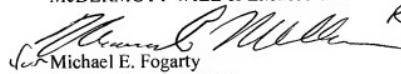
Submitted herewith is Appellant's Appeal Brief in support of the Notice of Appeal filed November 6, 2009. Please charge the Appeal Brief fee of \$540.00 to Deposit Account 500417.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made.

Please charge any shortage in fees due under 37 C.F.R. 1.17 and 41.20, and in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

McDERMOTT WILL & EMERY LLP


Michael E. Fogarty
Registration No. 36,139

Reg. No. 53,308

600 13th Street, N.W.
Washington, DC 20005-3096
Phone: 202.756.8000 MEF:NDM
Facsimile: 202.756.8087
Date: January 6, 2010

Please recognize our Customer No. 53080
as our correspondence address.

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

In re Application of : Customer Number: 53080
Yasuo TAKEBE, et al. : Confirmation Number: 5764
Application No.: 10/696,505 : Tech Center Art Unit: 1795
Filed: October 30, 2003 : Examiner: Raymond Alejandro
For: METHOD OF OPERATING FUEL CELL SYSTEM AND FUEL CELL SYSTEM AND FUEL SYSTEM

APPEAL BRIEF

Mail Stop Appeal Brief
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This Appeal Brief is submitted in support of the Notice of Appeal filed November 6, 2009, wherein Appellant appeals from the Primary Examiner's rejection of claim 107.

Real Party In Interest

This application is assigned to Panasonic Corporation (formerly Matsushita Electric Industrial Co.) by assignment recorded on November 21, 2008, at Reel 021897, Frame 0624.

Related Appeals and Interferences

To the best of Appellants' and Appellants' representatives' knowledge, there are no related appeals or interferences (see Related Proceedings Appendix).

Status of Claims

1. Claims canceled: 80-82.
2. Claims withdrawn from consideration, but not canceled: 1-79, 83-106 and 108-109.
3. Claims pending: 1-79, 83-109.
4. Claims allowed: None.
5. Claims rejected: 107.
6. Claims on appeal: 107.

Status of Amendments

No amendments have been made to the claims after the Office Action dated July 9, 2009.

Summary of Claimed Subject Matter

Independent claim 107 recites a method for operating a fuel cell comprising an electrolyte, (Spec 6:21-22)

an anode and a cathode sandwiching the electrolyte, (Spec 6:22-23) and

one pair of separator plates each having a gas flow path for feeding and discharging a fuel gas to the anode and for feeding and discharging an oxygen-containing gas to the cathode, (Spec 6:23-26)

the method comprising the steps of carrying out a restoring operation including: (Spec 6:26-27)

(A) operating the fuel cell while feeding the oxygen-containing gas to the cathode, (Spec 68:20-23)

(B) terminating feeding of the oxygen-containing gas to the cathode, (Spec 68:20-23)

and

(C) feeding a hydrocarbon gas that is a city gas desulfurized with a desulfurizer, a propane gas or a butane gas to the cathode instead of the oxygen-containing gas which has been fed to the cathode, (Spec 29:3-5) to decrease a potential of the cathode after terminating feeding of the oxygen-containing gas to the cathode. (Spec 28:31-29:2)

Grounds of Rejection To Be Reviewed By Appeal

- 1) Claim 107 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Fuller et al. (USP No. 6,068,941) in view of JP 11-67252.

Argument

- 1) Claim 107 is not obvious over Fuller in view of JP 11-67252.

The Examiner's Position:

The Examiner has rejected claim 107 under 35 U.S.C. § 103(a) as being unpatentable over Fuller et al. (USP No. 6,068,941) in view of JP 11-67252. The Examiner notes the failure of Fuller to disclose feeding a hydrocarbon gas that is a city gas desulfurized with a desulfurizer, a propane gas or a butane gas to the cathode instead of the oxygen-containing gas which has been fed to the cathode, to decrease a potential of the cathode after terminating feeding of the oxygen-containing gas to the cathode. Nor does the Examiner assert that JP 11-67252 teaches this limitation. However, the Examiner asserts that JP 11-67252 teaches a reformed city gas/combustion exhaust gas that reads upon the claimed limitation.

Appellants Position:

I. Fuller Does Not Disclose Feeding A Hydrocarbon Gas To The Cathode At Shutdown

a. An alcohol is not a hydrocarbon

Fuller fails to teach “feeding a hydrocarbon gas that is a city gas desulfurized with a desulfurizer, a propane gas or a butane gas to the cathode instead of the oxygen-containing gas”. The Examiner suggests that Fuller teaches feeding a hydrocarbon-based compound (an alcohol) to the cathode after terminating operation of the fuel cell. However, an alcohol is not a hydrocarbon, nor a hydrocarbon city gas. The Examiner states in section 7, line 13 of the July 9, 2009 Office Action that alcohol (a hydrocarbon based material) diffuses to the cathode. This point is moot. Claim 107 does not recite “hydrocarbon based”. The mere fact that an alcohol may be considered “hydrocarbon based” does not render an alcohol a “hydrocarbon”. Hydrocarbons are clearly defined in the art as compounds containing only hydrogen and carbon (Hawley’s Condensed Chemical Dictionary, 12th Ed.). As such, one skilled in the art would not interpret an alcohol as a hydrocarbon.

b. An aqueous alcohol is not a hydrocarbon gas

Moreover, the alcohols used by Fuller are not in gaseous form. As is taught by Fuller, the alcohol is added to the coolant passages during shutdown to replace water in the coolant lines with an aqueous mixture of alcohol to prevent freezing (see, col. 2, lines 56-67). A mixture of 41% methanol or 54% ethanol is required. As such, Fuller does not teach either feeding a hydrocarbon, or a gas, much less a hydrocarbon gas, to the cathode.

c. The aqueous alcohol of Fuller is not added to the cathode to decrease potential of the cathode

Furthermore, Fuller fails to disclose “to decrease a potential of the cathode after terminating feeding of the oxygen-containing gas to the cathode”. The addition of alcohol to the cathode as

disclosed by Fuller is for a completely different purpose than that of adding the hydrocarbon gas to the cathode as in the present disclosure. As stated above, the alcohol is added to *prevent freezing*, and then later oxidized to start up a cold fuel cell. In contrast, the hydrocarbon of the present disclosure is added to the cathode after terminating feeding of the oxygen-containing gas to the cathode *to decrease the potential of the cathode* during shut down. As such, the alcohol of Fuller is not an equivalent or used in an equivalent manner as that of the hydrocarbon of the present disclosure.

- d. Fuller does not disclose adding the alcohol to the cathode after terminating feeding of the oxygen-containing gas

Nowhere does Fuller suggest that the alcohol is added to the cathode after terminating feeding of the oxygen-containing gas. It is alleged on page 5, lines 1-3 of the July 9, 2009 Office Action that “thus, there is a hydrocarbon-based material in the cathode after terminating operation of the fuel cell”. However, this is not the same as feeding a hydrocarbon gas...to the cathode after terminating feeding of the oxygen-containing gas to the cathode. It is only after adding the alcohol to the coolant lines that the alcohol diffuses to the cathode. Moreover, since Fuller teaches feeding air (oxygen containing gas) to the cathode at start-up (to heat the cold fuel cell), then Fuller does not teach feeding a hydrocarbon gas after termination of the oxygen containing gas. Accordingly, it is clear that Fuller does not disclose “feeding a hydrocarbon gas that is a city gas desulfurized with a desulfurizer, a propane gas or a butane gas to the cathode instead of the oxygen-containing gas which has been fed to the cathode, to decrease a potential of the cathode after terminating feeding of the oxygen-containing gas to the cathode”.

II. The "Specific Gas" of JP 11-67252 Cannot Be Substituted In Place of the Alcohol of Fuller

As discussed above, the Examiner has alleged that Fuller discloses the limitations of claim 107, specifically, feeding a hydrocarbon gas that is a city gas desulfurized with a desulfurizer, a propane gas or a butane gas to the cathode instead of the oxygen-containing gas which has been fed to the cathode, to decrease a potential of the cathode after terminating feeding of the oxygen-containing gas to the cathode. On page 5 of the Office Action, the Examiner admits to the failure of Fuller to expressly disclose supplying the specific gas for replacing oxygen and restoring the cathode.

However, the Examiner has made no showing that the “hydrocarbon-based material” of Fuller (methanol or ethanol) is used to decrease the potential of the cathode. The addition of the alcohol has NOTHING to do with decreasing the potential of the cathode. Rather, as indicated above, the alcohol of Fuller is used to prevent freezing of the fuel cell and to help with cold start up of the fuel cell. Accordingly, the Examiner has failed to demonstrate that the alcohol may be used for decreasing the potential of the cathode.

Yet, the Examiner goes on to attempt to replace the alcohol of Fuller with the city gas of JP 11-67252. Is the Examiner suggesting to circulate city gas in the cooling lines of Fuller to prevent freezing? Because that is the purpose of the alcohol of Fuller. One skilled in the art would know that a gas would not be able to mix with water in the cooling lines to prevent it from freezing. Thus, the Examiner has improperly combined the two references by suggesting that the alleged city gas of JP 11-67252, the definition of which will be discussed infra, can be used in place of the alcohol of Fuller.

The Examiner glosses over this point by discussing how the alleged city gas of JP 11-67252 may be used as a purge gas. The Examiner continues on pages 8-10, freely admitting that the combination of Fuller and JP 11-67252 fails to disclose all of the limitations of claim 107. The

Examiner suggests that the Fuller “*implies* termination of feeding air/oxidant” (see, page 9, line 1 of Office Action). Yet, as mentioned above, the Examiner also admits that Fuller adds air during startup, which Fuller uses to oxidize the alcohol present at the cathode. Thus, Fuller does not imply termination of feeding air/oxidant.

As such, the Examiner has failed to show how the combination of Fuller and JP 11-67252 teaches the steps of (A) operating the fuel cell while feeding the oxygen-containing gas to the cathode, (B) terminating feeding of the oxygen-containing gas to the cathode, and (C) feeding a hydrocarbon gas that is a city gas desulfurized with a desulfurizer, a propane gas or a butane gas to the cathode instead of the oxygen-containing gas which has been fed to the cathode, to decrease a potential of the cathode after terminating feeding of the oxygen-containing gas to the cathode.

III. Interpretation Of “City Gas”

The Examiner alleges, in section 12, lines 4-6 of the July 9, 2009 Office Action that “the chemical composition of the Applicant’s hydrocarbon city gas does not appear to be critical...because the Applicant does not define it.” As is well known in patent law, the words of a claim must be given their plain meaning. *In re Zletz* 893 F.2d 319, 321, 13 USPQ2d 1320, 1322 (Fed. Cir. 1989). The plain meaning is the ordinary and customary meaning given to the term by those skilled in the art. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313, 75 USPQ2d 1321, 1326 (Fed. Cir. 2005). It is not up to the Examiner’s discretion as to decide how “critical” an Applicant views a claim term. On the contrary, the term “city gas” is critical to the present application, the definition of which was discussed in previously submitted Kojien, page 1732, published on October 6, 1986, and Nihongo Dai Jiten, pages 1399-1400, published on January 28, 1992 or in US 2009/0117421 cited by the Examiner.

IV. JP 11-67252 Fails To Disclose Feeding A “City Gas” To The Cathode

It is asserted in section 12, lines 9-11 of the pending Office Action that “it is not unreasonable to conclude that the reformed city gas of JP 11-67252 is capable of decreasing the potential of the fuel cell” in the same manner as the city gas of claim 107. As such, the Examiner mistakenly compares the alleged “reformed city gas” of JP 11-67252 with the city gas of claim 107. In addition, the Examiner alleges in section 12, lines 13-14 that “in JP 11-67252, as explained above, the intended use of the city gas in the anode side (which is purging gas) would be suitable for the cathode side of the fuel cell.”

Foremost, nowhere in JP 11-67252 is there any specific mention of a “reformed city gas”. In JP 11-67252, an “anode gas” is generated by reforming the “city gas” in a reformer 22 and supplied to an anode of the fuel cell 20. An anode exhaust gas, which is exhausted from the anode of the fuel cell, is combusted in a combustor 23 to generate “combustion exhaust gas”. A part of this combustion exhaust gas is supplied to a housing 21 accommodating the fuel cell 20. Thus, the “combustion exhaust gas” which is supplied to the cathode should be compared with the city gas of claim 107, not the “reformed city gas”, which is supplied to the anode.

Moreover, JP 11-67252 does not teach feeding the anode gas to the cathode. A part of the combustion exhaust gas is supplied to the cathode of the fuel cell 20 through a carbon dioxide gas recycle line 7, as is recited in the Abstract. Then, the combustion exhaust gas reacts with the anode gas to generate electricity. Thus, the combustion exhaust gas is an oxidizing gas, as compared to the anode gas, which is a reducing gas. Accordingly, it is clear that the combustion exhaust gas and the anode gas have completely different compositions. Further, the Examiner’s assertion that the intended use of the city gas in the anode side would be suitable for the cathode side of the fuel cell, is completely unreasonable.

Since the city gas of claim 107 is defined as in Reference 1 or Reference 2 as a natural gas or the like, it is clearly different than the combustion exhaust gas, which contains carbon dioxide, which is clearly not a hydrocarbon. Moreover, the combustion exhaust gas of JP 11-67252 contains oxygen in order to combust the anode exhaust gas. As is well known in the art, oxygen is supplied in excess in order to completely combust the anode exhaust gas during the anode exhaust combustion step. This is further evidenced by the fact that the combustion exhaust gas is supplied to the cathode and used as an oxidizing gas. Therefore, JP 11-67252 does not disclose the limitation of claim 107 of feeding a hydrocarbon gas that is a city gas desulfurized with a desulfurizer, a propane gas or a butane gas to the cathode instead of the oxygen-containing gas which has been fed to the cathode.

V. **The City Gas Of JP 11-67252 Is Not Supplied To The Anode Either**

In section 14, lines 7-8 of the Office Action, the Examiner states “there is no dispute that the city gas in JP ‘252 is fed to the anode”. Further, the Examiner alleges, on page 14, lines 8-10 that “there is also no dispute what is the intended use of the city gas in the JP ‘252 which is to act as a purging gas, and not as a fuel or reactant.”

JP 11-67252 does not teach supplying “city gas” to the anode. The gas supplied to the anode 20 is “anode gas”. Anode gas is generated by converting city gas into anode gas. This process results in the creation of large amounts of hydrogen gas. This makes perfect sense because in order to allow the anode gas to react with oxidizing gas, it must contain hydrogen gas. However, as agreed upon by the Examiner and the Appellant supplied references, city gas contains hydrocarbons, not hydrogen, and accordingly, would not react readily with the oxidizing gas at the anode. If the city gas were able to react with the oxidizing gas, there would be no need to convert the city gas into anode gas, as disclosed in JP 11-67252. As such, it is clear that city gas is not supplied to the anode in JP 11-67252.

VI. JP 11-67252 Fails To Disclose Purging A Fuel Cell With Combustion Exhaust Gas

The Examiner asserts on page 5, lines 11-12 of the pending Office Action that the reformed city gas/combustion exhaust gas is used as a purge gas to purge the fuel cell. The Examiner is incorrect on each statement and incorrectly interprets JP 11-67252.

According to the Abstract and Fig. 2 of JP 11-67272, during operation of the fuel cell, the shut-off valve 52 is closed. Because of this, a part of the combustion exhaust gas flowing in the carbon dioxide gas recycle line 7 is branched into the exhaust line 16, cooled in the cooling device 50, and flowed into the purge gas line 15. A gas-liquid separator 37 then removes the water and pressurizes the remaining gas in the purge gas blower 38, feeds the pressurized gas into the housing 21 and purges remaining gas in the housing 21. It then flows through line 13 and joins the combustion exhaust gas flowing in the carbon dioxide gas recycle line 7 at the blower entrance 32. There, the blower supplies the cathode of the fuel cell 20 with the combustion exhaust gas, which has already been identified as an oxygen containing oxidizing gas (see, paragraphs [0014]-[0017] of JP 11-67252).

Thus, contrary to the Examiner's statement, the combustion exhaust gas serves to purge the interior of the housing 21 accommodating the fuel cell 20 and is used as an oxygen containing gas in the cathode. Therefore, the combustion exhaust gas does not purge the interior of the fuel cell, even during an emergency stop. In fact, the operation of the fuel cell during an emergency stop is not clearly identified by the Abstract. The fuel cell of JP 11-67252 is clearly a molten carbonate fuel cell (MCFC) which normally operates at 650 °C. As such, one skilled in the art would not purge the interior of the fuel cell with 650 °C gas and release the remaining gas to the outside in an emergency stop. Thus, in JP 11-67252, the anode gas generated by reforming city gas is only supplied to a fuel cell as a fuel gas, and is not used for purging as suggested by the Examiner.

In order to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. As Fuller and JP 11-67252, at a minimum, fail to describe a method for operating a fuel cell...comprising the steps of carrying out a restoring operation including: (A) operating the fuel cell while feeding the oxygen-containing gas to the cathode, (B) terminating feeding of the oxygen-containing gas to the cathode, and (C) feeding a hydrocarbon gas that is a city gas desulfurized with a desulfurizer, a propane gas or a butane gas to the cathode instead of the oxygen-containing gas which has been fed to the cathode, to decrease a potential of the cathode after terminating feeding of the oxygen-containing gas to the cathode, it is submitted Fuller and JP 11-67252, alone or in combination, do not render claim 107 obvious. Accordingly, it is respectfully requested that the § 103 rejection of claim 107 be withdrawn.

Conclusion

For at least the above-cited arguments, Appellants respectfully submit that the combination of Fuller and JP 11-67252 does not suggest the limitations of claim 107, an acknowledgment of which is respectfully solicited.

For all of the foregoing reason, Appellant respectfully submits that the grounds of rejection of the claims on appeal is in error and should be reversed.

Respectfully submitted,

McDERMOTT WILL & EMERY LLP


for Michael E. Fogarty
Registration No. 36,139

Res No 53,308

600 13th Street, N.W.
Washington, DC 20005-3096
Phone: 202.756.8000 MEF:NDM
Facsimile: 202.756.8087
Date: January 6, 2010

**Please recognize our Customer No. 53080
as our correspondence address.**

CLAIMS APPENDIX

107. A method for operating a fuel cell comprising an electrolyte, an anode and a cathode sandwiching the electrolyte, and one pair of separator plates each having a gas flow path for feeding and discharging a fuel gas to the anode and for feeding and discharging an oxygen-containing gas to the cathode,

the method comprising the steps of carrying out a restoring operation including:

(A) operating the fuel cell while feeding the oxygen-containing gas to the cathode,

(B) terminating feeding of the oxygen-containing gas to the cathode, and

(C) feeding a hydrocarbon gas that is a city gas desulfurized with a desulfurizer, a propane gas or a butane gas to the cathode instead of the oxygen-containing gas which has been fed to the cathode, to decrease a potential of the cathode after terminating feeding of the oxygen-containing gas to the cathode.

EVIDENCE APPENDIX

1. Kojien, page 1732, published on October 6, 1986.
2. Nihongo Dai Jiten, pages 1399-1400, published on January 28, 1992.
3. Hawley's Condensed Chemical Dictionary, 12th Ed., p. 30-31, 612.

編者 新村出(しんむら いづる)
明治 9 年山口県に生る。言語学を専攻。東大助教授を経て京大教授。特にキリシタン語学に新面をひらき、源流説認証に卓見を示す。文化勲章受章。昭和 42 年 8 月没。
著者 「南蛮更次」「南蛮宏記」「東方言語史
略考」「東亞語彙志」

坐者「兩翼更杪」，兩翼即記」，東方音韻大
體者「東西語譜志」。

著者、「東亞語辭志」

Reference 2

講談社 カラー版
日本語大辞典

定価 7300円(本体7080円)

発行 一九八九年一月六日 第一刷発行

一九九一年一月二八日 第二刷発行

監修 柴林忠夫 金田一春彦、阪倉篤義、日野原重明

発行者 齊藤佐和子

発行所 株式会社 講談社



〒111-110 東京都文京区音羽二-1-1-11

編集部 03-13659311

販売部 03-15339113-13614

制作部 03-15339113-13615

印刷所 大日本印刷株式会社

製本所 大日本製本印刷株式会社

座本・底本は、小社蔵書の部であることを記す

送本・小社蔵本は、おどかえいたしま。

など、こなじての間違ったセイ。

小社蔵本は、おどかえいたしま。

©KODANSHA 1989 Printed in Japan

ISBN 4-62-121097-2 (平)

Reference 3

Hawley's

Condensed Chemical

Dictionary

TWELFTH EDITION

Revised by

Richard J. Lewis, Sr.



VAN NOSTRAND REINHOLD COMPANY
New York

(5-amino-4-imidazole carboximide riboside-5'-triphosphate).
See also nucleotide.

"Alathon" [Du Pont]. TM for a polyethylene resin. "Alathon" G-0530, designated as a reinforced polyethylene, contains 30% by weight of glass fiber treated with a proprietary coupling agent that optimizes its reinforcing properties.

Albert furnace. A reverberatory furnace for roasting mercury ores, the mercury being condensed in iron tubes and brick chambers.

Albert-Precht effect. A technique used in photography to produce a reversed image. The exposed surface is immersed in chromic acid. It is then exposed to uniform light and developed over.

"Albigen" [BASF]. TM for a water-soluble polymer used in the textile industry for stripping vat and other dyestuffs. Has no affinity for the fiber; promotes the stripping effect of alkaline hydrosulfite solutions.

"Albion Spperse" [Albion]. CAS: 1332-58-7.
TM for pure low iron and low alkali kaolin.
Use: As raw material to refractories, chemical, ceramic, rubber adhesives, fiberous glass, catalysts, filler, and paper.

"Albone" [Du Pont]. TM for a series of hydrogen peroxide solutions which vary in hydrogen peroxide content from 35% to 90% by weight.
See hydrogen peroxide.

albumen. Commercial term for dried egg white used in the food industry.
See albumin, egg.

albumin. Any of a group of water-soluble proteins of wide occurrence in such natural products as milk (lactalbumin), blood serum, and eggs (ovalbumin). They are readily coagulated by heat and hydrolyze to α -amino acids or their derivatives.
See following entries.

albumin, egg. (ovalbumin). Chief protein occurring in egg white as a viscous, colorless fluid; it becomes an amorphous solid when dried, which can be reconstituted with water. It is a heat-sensitive colloidal material which coagulates irreversibly at approximately 60°C (140°F). The dried product is available in commercial quantities.

Use: Protective colloid and emulsifying agent in bakery products (especially angel cake), clarification of wines, adhesives, paper coatings, pharmaceuticals, enzyme activation, lithography,

analytical reagent, antidote for mercury poison-ing, mordant in dyes.

Note: A recombinant DNA technique has made possible the formation of ovalbumin by the bacterium *E. coli*.

albumin, milk. (lactalbumin). A component of skim milk protein (2 to 5%). Can be crystallized. Exact function is not known, but probably aids in stabilization of the fat particles.
See also milk.

ALCA. See American Leather Chemists' Association.

alchemy. The predecessor of chemistry, practiced from as early as 500 BC through the 16th century. Its two principal goals were transmutation of the baser metals into gold and discovery of a universal remedy. Modern chemistry grew out of alchemy by gradual stages.

alchlor process. To remove the unstable components of lubricating oil, this process used aluminum chloride instead of sulfuric acid.

alcian blue.

Properties: Greenish-black crystals with metallic sheen. Soluble in ethanol, cellosolve, ethylene glycol.

Use: Gelling agent for lubricating fluids, bacterial stain for histiocytes and fibroblasts.

Alcoa process. A more efficient method of producing aluminum from bauxite which requires one-third less electric power than the Hall process. Alumina is reacted with chlorine, the resulting aluminum chloride yielding the metal and chlorine on electrolysis. No fluorine is required in the process. Prototype plants are under development.

alcohol. A broad class of hydroxyl-containing organic compounds occurring naturally in plants and made synthetically from petroleum derivatives such as ethylene. Many are manufactured in tonnage quantities.

The many types may be summarized as follows:

- I. Monohydric (1 OH group)
 1. Aliphatic
 - (a) paraffinic (ethanol)
 - (b) olefinic (allyl alcohol)
 2. Alicyclic (cyclohexanol)
 3. Aromatic (phenol, benzyl alcohol)
 4. Heterocyclic (furfuryl alcohol)
 5. Polycyclic (sterols)
- II. Dihydric (2 OH groups): glycols and derivatives (diols)
- III. Trihydric (3 OH groups): glycerol and derivatives
- IV. Polyhydric (polyols) (3 or more OH groups)

Use: Organic synthesis for solvents, detergents, beverages, pharmaceuticals, plasticizers, and fuels.

For further information, see monohydric, dihydric, trihydric, polyol, and specific alcohol.

alcohol, absolute. See ethyl alcohol.

alcohol dehydrogenase. An enzyme found in animal and plant tissue which acts upon ethanol and other alcohols producing acetaldehyde and other aldehydes.

Use: Biochemical research.

alcohol, denatured. CAS: 64-17-5. Ethanol to which another liquid has been added to make it unfit to use as a beverage (chiefly for tax reasons). In the U.S., it may be either Completely Denatured (CDA) or Specially Denatured (SDA). At least 50 formulations are authorized officially for making denatured alcohol. They include the following denaturants: SDA 40B must contain brucine, brucine sulfate, or quassain plus tert-butanol; SDA 40A must contain sucrose octaacetate plus tert-butyl alcohol; SDA 40B must contain Bitrex and tert-butyl alcohol; SDA40C must contain only tert-butyl alcohol. For exact formulas, consult 27CFR Part 21 and the Alcohol and Tobacco Tax Division of IRS, Washington, DC.

Properties: See ethanol.

Hazard: Flammable, dangerous fire risk; TLV: 1000 ppm in air.

Use: Manufacture of acetaldehyde and other chemicals, solvents, antifreeze and brake fluids, fuels.

alcohol, grain. Ethanol made from grain.

alcohol, industrial. A mixture of 95% ethanol and 5% water, plus additives for denaturing or special solvent purposes. See also alcohol, denatured.

alcohol, wood. See methyl alcohol.

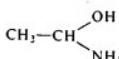
alcoholysis. A chemical reaction between an alcohol and another organic compound analogous to hydrolysis. The alcohol molecule decomposes to form a new compound with the reacting substance; the other reaction product being water. Both hydrolysis and alcoholysis may be considered as forms of solvolysis. See also solvolysis.

"**Aldactazide**" [Searle]. TM for a combination of spironolactone and hydrochlorothiazide. **Use:** Drug.

"**Aldactone**" [Searle]. TM for spironolactone. **Use:** Drug.

aldehyde. A broad class of organic compounds having the generic formula RCHO, and characterized by an unsaturated carbonyl group ($C=O$). They are formed from alcohols by either dehydrogenation or oxidation, and thus occupy an intermediate position between primary alcohols and the acids obtained from them by further oxidation. Their chemical derivation is indicated by the name: *alcohol + dehyd*(rogenation). Aldehydes are reactive compounds participating in oxidation, reduction, addition, and polymerization reactions. For specific properties, see individual compounds.

aldehyde ammonia. (acetaldehyde ammonia; 1-amino-ethanol). $CH_3CH_2ONH_2$.



Properties: White, crystalline solid; stable in closed containers; resinifies on long exposure to air. Very soluble in water and alcohol. Mp 97°C (partly decomposes).

Derivation: Action of acetaldehyde on ammonia. **Hazard:** Irritant to eyes and skin; moderate fire risk.

Use: Accelerator for vulcanization of thread rubber, organic synthesis, source of acetaldehyde and ammonia.

aldehyde collidine. See 2-methyl-5-ethylpyridine.

Alder, Kurt. (1902-1958). A German chemist who won the Nobel prize for chemistry along with Otto Diels in 1950 for a project involving a practical method for making ring compounds from chain compounds by forcing them to combine with maleic anhydride. This is known as the Diels-Alder reaction and provided a method for synthesis of complex organic compounds. He had degrees from the Universities of Berlin and Kiel.

Alder-Rickert rule. Adducts of 1,3-cyclohexadiene derivatives with acetylenedicarboxylic esters give phthalate ester and ethylene on heating. Similar adducts of cyclopentadiene revert on heating to starting materials (retro-Diels-Alder).

Alder-Stein rules. Set of rules governing the stereochemistry of the Diels-Alder reaction. The most important are: (1) The stereochemical relationship of groups attached to the diene and the dienophile is maintained in the product (cis-addition). (2) The product resulting from maxi-

gas at room temperature), a constant-boiling solution is formed (bp 127, d 1.7) containing 57% hydrogen iodide; strong acid and an active reducing agent.

Derivation: (1) By passing hydrogen with iodine vapor over warm platinum sponge and absorption in water. (2) By the action of iodine on a solution of hydrogen sulfide.

Grade: Technical, 47%; NF, diluted, 10%.

Hazard: Strong irritant to eyes and skin.

Use: Preparation of iodine salts, organic preparations, analytical reagent, disinfectant, pharmaceuticals.

See also hydrogen iodide.

hydroabietyl alcohol. See dihydroabietyl alcohol.

hydrobiotite. A natural ore of magnesium, iron, and aluminum silicate occurring in Montana. Source of verite.

hydroboration. The reaction of diboranes either with alkenes (olefins) to form trialkylboron compounds or with acetylene to yield alkylboranes. Much research has been devoted to developing these reactions, the products of which are called organoboranes. They are useful in many complex organic syntheses, including prostaglandins and insect pheromones. See also borane, organoborane, carbaborane.

hydrobromic acid. CAS: 10035-10-6. Hydrogen bromide in aqueous solution.

Properties: Colorless or faintly yellow liquid consisting of an aqueous solution of hydrogen bromide, which is a gas at room temperature. Soluble in water and alcohol, a constant-boiling solution is formed of d 1.49, containing 48% hydrogen bromide; bp at 700 mm Hg (122°C), saturated solution contains 68.8% hydrogen bromide at 0°C. Hydrobromic acid is a strong acid and sensitive to light. Non-combustible.

Derivation: By dissolving hydrogen bromide in water or by distilling from a mixture of sodium bromide and 50% sulfuric acid.

Grade: Technical 40%; medicinal 48%, 62%.

Hazard: Strong irritant to eyes and skin.

Use: Analytical chemistry, solvent for ore minerals, manufacture of inorganic and some alkyl bromides, alkylation catalyst. See also hydrogen bromide.

hydrocarbon. An organic compound consisting exclusively of the elements carbon and hydrogen. Derived principally from petroleum, coal tar, and plant sources. Following is a résumé of the principal types.

1. Aliphatic (straight-chain)

(1) Paraffins (alkanes): generic formula C_nH_{2n+2} . Saturated, single bonds only.

(2) Olefins: generic formula C_nH_{2n} .

(a) alkenes: unsaturated (one double bond).

(b) alkadienes: unsaturated (two double bonds) (butadiene).

(3) Acetylenes: generic formula C_nH_{2n-2} . Unsaturated (triple bond).

(4) Acyclic terpenes. Unsaturated (polymers of isoprene, C_5H_8).

Note: Some aliphatic compounds have branched chains in which the subchain also contains carbon atoms (isobutane); both chains are essentially straight.

II. Cyclic (closed ring)

(1) Alicyclic: three or more carbon atoms in a ring structure with properties similar to those of aliphatics.

(a) Cycloparaffins (naphthenes): saturated compounds often having a boat or chair structure, e.g., cyclohexane, cyclopentane.

(b) Cycloolefins: unsaturated, two or more double bonds, e.g., cyclopentadiene (2), cyclooctatetraene (4).

(c) Cycloacetylenes (cyclenes): unsaturated (triple bond).

(2) Aromatic: unsaturated, hexagonal ring structure (three double bonds), single rings and double or triple fused rings.

(a) benzene group (1 ring).

(b) naphthalene group (2 rings).

(c) anthracene group (3 rings).

(3) Cyclic terpenes: monocyclic (dipentene); bicyclic (pinene).

Note: Olefinic (isoprenoid) hydrocarbons are produced by a number of plants; notably *Hevea brasiliensis* (rubber), guayule, and various members of the Euphorbiaceae family. Current research on the latter group indicates that they could be used as a source of liquid fuels and chemical feedstocks by genetic modification of the plants and control of their molecular constitution. It is estimated that oil obtained by large-scale cultivation of such plants, which grow well in semi-arid environments, could become economically competitive with petroleum within a few years.

See also guayule, biomass, copaiba.

hydrocarbon gas streams. A hydrocarbon such as methane is contacted with a catalyst under moderate conditions of temperature and pressure and decomposed into carbon, which remains on the catalyst, and hydrogen, which is mechanically removed. The hydrogen produced is about 94% pure when the charge stock is methane.

hydrocarbon, halogenated. A hydrocarbon in which one or more of the hydrogen atoms has been replaced by fluorine, chlorine, bromine, or iodine. Examples: carbon tetrachloride, chloro-

RELATED PROCEEDINGS APPENDIX

There are no related proceedings associated with this Appeal.